~~200211102~~

~~2~~ New U.S. Application
Docket No. 32860-000549/US

~~Patent claims~~What is claimed is:

1. ~~A~~M method for balancing capacitors in a capacitor bank, comprising:
~~characterized in that~~ producing three voltage levels ~~are produced by~~from a reference voltage source ~~in order~~, to monitor the state of charge of the capacitors,
determining ~~in that the~~ a capacitor voltage ~~on~~ for each capacitor ~~is determined~~ and ~~is~~ comparing~~d~~ the determined voltages with the produced voltage levels~~;~~; ~~and~~

~~in that~~ indicating a correct charge for a capacitor ~~on a capacitor is indicated~~ when a corresponding~~the~~ capacitor voltage is determined to be between the two relatively lower voltage levels~~;~~;
~~in that~~ indicating a fault in ~~the~~ a capacitor ~~is indicated~~ when ~~the~~ a corresponding capacitor voltage is greater than the relatively highest voltage level~~;~~; and
~~in that~~ balancing the capacitors ~~is carried out~~ only when neither a correct charge nor a fault is indicated.

2. The method as claimed in claim 1, wherein
~~characterized in that~~ a fault in a~~the~~ capacitor is indicated when a~~the~~ gradient of the capacitor voltage ~~on the capacitor~~ during the charging of the capacitor, exceeds a limit value.

3. The method as claimed in ~~one of~~ claim~~s~~ 1 ~~or 2~~, wherein
~~characterized in that~~ the voltage levels are supplied via optocouplers to an evaluation device.

4. The method as claimed in ~~one of~~ claim~~s~~ 1 ~~to 3~~, wherein
~~characterized in that~~ the reference voltage source uses a voltage ~~which is~~ present in the capacitor bank.

5. The method as claimed in claim 4,
~~characterized in that the~~wherein a sum voltage across two capacitors in the capacitor bank is tapped off as a reference voltage source for balancing.

~~200311102~~

6. The method as claimed in ~~one of~~ claims ~~1 to 5~~, wherein ~~characterized in that~~, after charging the capacitors, normal operation is started for one capacitor when the corresponding capacitor voltage reaches the relatively lowest voltage level and before the corresponding capacitor voltage has ~~not yet~~ reached the relatively central voltage level;~~,~~ wherein ~~in that~~ balancing ~~operation starts~~begins ~~-~~when the corresponding capacitor voltage has reached the relatively central voltage level, and ends when the capacitor voltage has once again reached the relatively lowest voltage level;~~,~~

~~in that~~wherein, when the relatively lowest voltage level is reached once again, normal operation is once again started, and ~~in that~~ ~~-~~wherein a fault is indicated ~~on~~ upon reaching the relatively highest voltage level.

7. The method as claimed in claim 6, wherein ~~characterized in that~~, in order to start balancing operation, the capacitor voltages of all the capacitors are raised above the relatively central voltage level.

8. An apparatus for carrying out the method as claimed in ~~one of~~ claims ~~1 to 7~~, comprising:
~~characterized in that~~ a series circuit formed from a non-reactive resistor and a first transistor, ~~is~~ arranged in parallel with ~~in each case~~ at least two ~~or more~~ capacitors in the capacitor bank~~;~~;
~~in that~~ at least one further transistor, ~~is~~ connected in parallel with the first transistor, wherein ~~;~~
~~in that~~ the transistors are connected to an evaluation device, ~~;~~ and wherein
~~in that~~ voltage taps on the capacitors are ~~are~~ connected to the evaluation device.

9. The apparatus as claimed in claim 8, further comprising ~~characterized in that~~ optocouplers, ~~are provided in order~~ adapted to transmit the voltage levels to a bus system.

~~200211102~~

10. The apparatus as claimed in claim 9, wherein ~~characterized in that~~ a double coupler is used instead of three optocouplers.

11. The method as claimed in claim 2, wherein the voltage levels are supplied via optocouplers to an evaluation device.

12. The method as claimed in claim 2, wherein the reference voltage source uses a voltage present in the capacitor bank.

13. The method as claimed in claim 12, wherein a sum voltage across two capacitors in the capacitor bank is tapped off as a reference voltage source for balancing.

14. The method as claimed in claim 2, wherein, after charging the capacitors, normal operation is started for one capacitor when the corresponding capacitor voltage reaches the relatively lowest voltage level and before the corresponding capacitor voltage has reached the relatively central voltage level;

wherein balancing begins when the corresponding capacitor voltage has reached the relatively central voltage level, and ends when the capacitor voltage has once again reached the relatively lowest voltage level;

wherein, when the relatively lowest voltage level is reached once again, normal operation is once again started, and

wherein a fault is indicated upon reaching the relatively highest voltage level.

15. The method as claimed in claim 14, wherein, in order to start balancing operation, the capacitor voltages of all the capacitors are raised above the relatively central voltage level.

16. The method as claimed in claim 3, wherein, after charging the capacitors, normal operation is started for one capacitor when the corresponding capacitor voltage reaches the relatively lowest voltage level and before the corresponding capacitor voltage has reached the relatively central voltage level;

wherein balancing begins when the corresponding capacitor voltage has reached the relatively central voltage level, and ends when the capacitor voltage has once again reached the relatively lowest voltage level;

wherein, when the relatively lowest voltage level is reached once again, normal operation is once again started, and

wherein a fault is indicated upon reaching the relatively highest voltage level.

17. The method as claimed in claim 16, wherein, in order to start balancing operation, the capacitor voltages of all the capacitors are raised above the relatively central voltage level.

18. The method as claimed in claim 4, wherein, after charging the capacitors, normal operation is started for one capacitor when the corresponding capacitor voltage reaches the relatively lowest voltage level and before the corresponding capacitor voltage has reached the relatively central voltage level;

wherein balancing begins when the corresponding capacitor voltage has reached the relatively central voltage level, and ends when the capacitor voltage has once again reached the relatively lowest voltage level;

wherein, when the relatively lowest voltage level is reached once again, normal operation is once again started, and

wherein a fault is indicated upon reaching the relatively highest voltage level.

19. The method as claimed in claim 18, wherein, in order to start balancing operation, the capacitor voltages of all the capacitors are raised above the relatively central voltage level.

20. The method as claimed in claim 5, wherein, after charging the capacitors, normal operation is started for one capacitor when the corresponding capacitor voltage reaches the relatively lowest voltage level and before the corresponding capacitor voltage has reached the relatively central voltage level;

wherein balancing begins when the corresponding capacitor voltage has reached the relatively central voltage level, and ends when the capacitor voltage has once again reached the relatively lowest voltage level;

wherein, when the relatively lowest voltage level is reached once again, normal operation is once again started, and

wherein a fault is indicated upon reaching the relatively highest voltage level.

21. The method as claimed in claim 20, wherein, in order to start balancing operation, the capacitor voltages of all the capacitors are raised above the relatively central voltage level.

22. An apparatus for carrying out the method as claimed in claim 2, comprising:

a series circuit formed from a non-reactive resistor and a first transistor, arranged in parallel with at least two capacitors in the capacitor bank;

at least one further transistor, connected in parallel with the first transistor, wherein the transistors are connected to an evaluation device, and wherein voltage taps on the capacitors are connected to the evaluation device.

23. The apparatus as claimed in claim 22, further comprising optocouplers, adapted to transmit the voltage levels to a bus system.

24. The apparatus as claimed in claim 23, wherein a double coupler is used instead of three optocouplers.

25. An apparatus for carrying out the method as claimed in claim 6, comprising:

a series circuit formed from a non-reactive resistor and a first transistor, arranged in parallel with at least two capacitors in the capacitor bank;

at least one further transistor, connected in parallel with the first transistor, wherein the transistors are connected to an evaluation device,

and wherein voltage taps on the capacitors are connected to the evaluation device.

26. The apparatus as claimed in claim 25, further comprising optocouplers, adapted to transmit the voltage levels to a bus system.

27. The apparatus as claimed in claim 26, wherein a double coupler is used instead of three optocouplers.

28. A method for balancing capacitors in a capacitor bank, comprising:

determining a capacitor voltage for a plurality of the capacitors;

comparing the determined voltages with at least three voltage levels from a reference voltage source;

determining a correct charge for a capacitor upon a corresponding capacitor voltage being between two relatively lower voltage levels;

determining a fault for a capacitor upon a corresponding capacitor voltage being greater than a relatively highest voltage level; and

balancing capacitors upon neither a correct charge nor a fault being determined.

29. The method as claimed in claim 28, wherein a fault in a capacitor is determined when a gradient of the capacitor voltage during the charging of the capacitor, exceeds a limit value.

30. The method as claimed in claim 28, wherein the voltage levels are supplied via optocouplers to an evaluation device.

31. The method as claimed in claim 1, wherein the reference voltage source uses a voltage present in the capacitor bank.

32. The method as claimed in claim 31, wherein a sum voltage across two capacitors in the capacitor bank is tapped off as a reference voltage source for balancing.

33. The method as claimed in claim 28, wherein, after charging the capacitors, normal operation is started for one capacitor when the corresponding

capacitor voltage reaches the relatively lowest voltage level and before the corresponding capacitor voltage has reached the relatively central voltage level;

wherein balancing begins when the corresponding capacitor voltage has reached the relatively central voltage level, and ends when the capacitor voltage has once again reached the relatively lowest voltage level;

wherein, when the relatively lowest voltage level is reached once again, normal operation is once again started, and

wherein a fault is determined upon reaching the relatively highest voltage level.

34. The method as claimed in claim 33, wherein, in order to start balancing operation, the capacitor voltages of all the capacitors are raised above the relatively central voltage level.

35. An apparatus for carrying out the method as claimed in claim 28, comprising:

a series circuit formed from a non-reactive resistor and a first transistor, arranged in parallel with at least two capacitors in the capacitor bank;

at least one further transistor, connected in parallel with the first transistor, wherein the transistors are connected to an evaluation device, and wherein voltage taps on the capacitors are connected to the evaluation device.

36. The apparatus as claimed in claim 35, further comprising optocouplers, adapted to transmit the voltage levels to a bus system.

37. The apparatus as claimed in claim 36, wherein a double coupler is used instead of three optocouplers.

38. An apparatus for balancing capacitors in a capacitor bank, comprising:

means for determining a capacitor voltage for a plurality of the capacitors;

means for comparing the determined voltages with at least three voltage levels from a reference voltage source;

means for determining a correct charge for a capacitor upon a corresponding capacitor voltage being between two relatively lower voltage levels;

means for determining a fault for a capacitor upon a corresponding capacitor voltage being greater than a relatively highest voltage level; and

means for balancing capacitors upon neither a correct charge nor a fault being determined.

39. The apparatus as claimed in claim 38, wherein a fault in a capacitor is determined when a gradient of the capacitor voltage during the charging of the capacitor, exceeds a limit value.

40. The apparatus as claimed in claim 38, wherein the voltage levels are supplied via optocouplers to an evaluation device.

41. The apparatus as claimed in claim 38, wherein the reference voltage source uses a voltage present in the capacitor bank.

42. The apparatus as claimed in claim 41, wherein a sum voltage across two capacitors in the capacitor bank is tapped off as a reference voltage source for balancing.

43. The apparatus as claimed in claim 38, wherein, after charging the capacitors, normal operation is started for one capacitor when the corresponding capacitor voltage reaches the relatively lowest voltage level and before the corresponding capacitor voltage has reached the relatively central voltage level;

wherein balancing begins when the corresponding capacitor voltage has reached the relatively central voltage level, and ends when the capacitor voltage has once again reached the relatively lowest voltage level;

wherein, when the relatively lowest voltage level is reached once again, normal operation is once again started, and

wherein a fault is determined upon reaching the relatively highest voltage level.

~~200211102~~

44. The apparatus as claimed in claim 43, wherein, in order to start balancing operation, the capacitor voltages of all the capacitors are raised above the relatively central voltage level.

45. An apparatus for balancing capacitors in a capacitor bank, comprising:

a series circuit, formed from a non-reactive resistor and a first transistor, arranged in parallel with at least two capacitors in the capacitor bank; and

at least one further transistor, connected in parallel with the first transistor, the transistors being connected to an evaluation device, wherein at least three voltage levels are produced from a reference voltage source, wherein a capacitor voltage is determined and compared to the at least three voltage levels, and wherein balancing of the capacitors begins when the capacitor voltage of all of the capacitors reaches a relatively central voltage level and ends when the capacitor voltage of all of the capacitors reaches a relatively lower voltage level.

46. The apparatus of claim 45, wherein a correct charge for a capacitor is indicated when a corresponding capacitor voltage is determined to be between the two relatively lower voltage levels and wherein a fault in a capacitor is indicated when a corresponding capacitor voltage is greater than the relatively highest voltage level.

47. The apparatus of claim 45, wherein voltage taps on the capacitors are connected to the evaluation device.

48. The apparatus of claim 45, wherein, when the relatively lowest voltage level is reached once again, normal operation is again started, and wherein a fault is indicated upon reaching the relatively highest voltage level.

49. A method for balancing capacitors in a capacitor bank, comprising:

determining a capacitor voltage of each capacitor in the capacitor bank;

comparing each capacitor voltage to at least three voltage levels produced from a reference source; and

balancing the capacitors upon the capacitor voltage of all of the capacitors reaching a relatively central voltage level and end the balancing upon the capacitor voltage of all of the capacitors reaching a relatively lower voltage level.

50. The method of claim 49, wherein, upon the relatively lowest voltage level being reached once again, normal operation is again started, and wherein a fault is indicated upon reaching the relatively highest voltage level.

51. The method of claim 49, further comprising:

determining a correct charge for a capacitor upon a corresponding capacitor voltage being between two relatively lower voltage levels;

determining a fault for a capacitor upon a corresponding capacitor voltage being greater than a relatively highest voltage level; and

balancing capacitors upon neither a correct charge nor a fault being determined.

52. An apparatus for balancing capacitors in a capacitor bank, comprising:

means for determining a capacitor voltage of each capacitor in the capacitor bank;

means for comparing each capacitor voltage to at least three voltage levels produced from a reference source; and

means for balancing the capacitors upon the capacitor voltage of all of the capacitors reaching a relatively central voltage level and end the balancing upon the capacitor voltage of all of the capacitors reaching a relatively lower voltage level.